

DISTRIBUTION, BIOLOGY AND CONSERVATION STATUS OF THE PEPPERMINT
STICK INSECT, *MEGACRANIA BATESII* (KIRBY) (PHASMATODEA:
PHASMATIDAE), IN QUEENSLAND

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Cermak, M. & Hasenpusch, J.W. 2000 12 31: Distribution, biology and conservation status of the peppermint stick insect, *Megacrania batesii* (Kirby) (Phasmatodea: Phasmatidae), in Queensland. *Memoirs of the Queensland Museum* 46(1): 101-106. Brisbane. ISSN 0079-8835.

Megacrania batesii was studied in the Wet Tropics region of north Queensland. Its natural history and distribution is reviewed and supplemented by observations in the field and in captivity. Surveys found a substantial, sexually-reproducing population at Cape Tribulation in a range of habitats. Three parthenogenic populations south of Cairns are confined to small patches of habitat adjacent to beaches. The reliance of *M. batesii* on *Pandanus* was confirmed and the range of *Pandanus* species eaten was expanded. The species is under no immediate threat but fits the IUCN criteria for Vulnerable on the basis that its population occurs over an area of less than 100km² and could be further threatened if any one subpopulation is extirpated. □ stick insects, Phasmatodea, Megacrania, survey, Pandanus, parthenogenesis, conservation, Queensland, Australia.

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The Peppermint Stick Insect, *Megacrania batesii* (Kirby), is a poorly known phasmid that, in Australia, has a restricted and patchy distribution in tropical northeast Queensland (Franzmann, 1974; Rentz, 1996) and the Sir Edward Pellew Islands in the Gulf of Carpentaria (Key, 1991; Rentz, 1996). This species is the sole representative of the subfamily Platycraninae in Australia (Key, 1991; Rentz, 1996; Vickery, 1983). Its type locality is the Solomon Islands (Kirby, 1896) and this author also refers to museum specimens from Malayan and Papuan islands, Aru and Kei Dulan, Philippines, Goram, Gilolo, Amboina and New Guinea, though it is clear he had reservations about the conspecificity of some. Modern published records for *Megacrania batesii* outside Australia include the Solomon Islands (Chia-Chi Hsuing, 1991; Vickery, 1983) and New Guinea (Van Herwaarden, 1998).

The first Australian specimens of *M. batesii* were collected at Etty Bay, north Queensland in 1971 and at Mission Beach in 1973 by Franzmann (1974). This author also described the peppermint secretion which the species squirts from two gland openings on the prothorax when disturbed, and illustrated the position of the gland openings. This secretion does not effect human skin (Franzmann, 1974) but irritates the eyes on contact (J. Seymour, pers. comm. Jan. 1999). Franzman (1974) also commented that only

females were ever found at these localities. Rentz (1993) draws attention to the vulnerable status of the species in Australia and refers to the Etty Bay population as being near 'Mackay' which is a lapse for Innisfail. No *M. batesii* males have been found south of the Daintree River, so the southern populations were assumed to be parthenogenic (Rentz 1996). The same author first refers to the presence of males in some populations, notes the peculiar locomotion of the species in which only the fore and mid legs are used, and records the foodplant as *Pandanus tectorius*. Brock (1999) also mentions that parthenogenic and bisexual populations occur along a few coastal parts of North Queensland and illustrates the eggs for the first time. However he incorrectly describes its locomotion as involving only the fore and hind legs. A line illustration is given of an Australian *Megacrania* by Key (1991) and colour photographs have been published by Rentz (1996), Hughes (1996) and Brock (1999).

This study aims to determine the full extent of the species' distribution in the wet tropics of North Queensland and to determine its conservation status. Observations of living specimens in the field and in captivity between 1991 and 1999 provided additional information on the behaviour and defence mechanisms of the species.

MATERIALS AND METHODS

Field surveys were conducted between November 1998 and February 1999. Preliminary surveys confirmed the presence of *M. batesii* at Cape Tribulation, Etty Bay and Bingil Bay (north of Mission Beach) (Fig. 1). Subsequent surveys were conducted to determine the limits to those three populations, and to identify other suitable areas containing *Pandanus* plants along the Wet Tropics coast.

Surveys were conducted by searching for partially defoliated *Pandanus* plants either from a vehicle or on foot. Presence/absence of *M. batesii* was recorded upon close examination of the plants. Chew marks caused by other insects feeding on *Pandanus* were recorded for comparison and a collection of *Pandanus* eating insects was compiled for future reference.

Survey sites were chosen by examining characteristics of known sites and choosing locations with broadly similar characteristics. In some areas along the coast north of the Daintree River, access was difficult. In these situations, surveys were conducted by searching transects along the Cape Tribulation road and coastal beaches; if *M. batesii* were found then transects were walked perpendicular to the beach and/or the road. These perpendicular transects were of no set length but were terminated 100m beyond the last occurrence of *M. batesii*. Some areas of the coastline (e.g. the northern aspect of Cape Kimberley) were totally inaccessible so were not surveyed. However all other accessible areas containing *Pandanus* between Donovan Range in the north and Tully Heads in the south (Fig. 1) were surveyed. Some areas of coast between the Daintree River and Bramston Beach were deemed unsuitable for *Megacrania* because of the lack of *Pandanus* or of suitable forest type. Proposed survey in the Yarrabah region, south of Cairns (which contains suitable habitats) was not possible. Forest types surveyed were characterised on the criteria of Tracey & Webb (1975) and Tracey (1987).

Observations of behaviour and predation were conducted opportunistically while surveying the distribution of *M. batesii*. Feeding and mating trials were conducted in the laboratory by introducing the insects onto different species of *Pandanus* and *Freycinetia*.

Body length measurements were obtained from a sample of 10 adult males from Cape Tribulation and 14 adult females (7 from Cape Tribulation and 7 from Etty Bay).

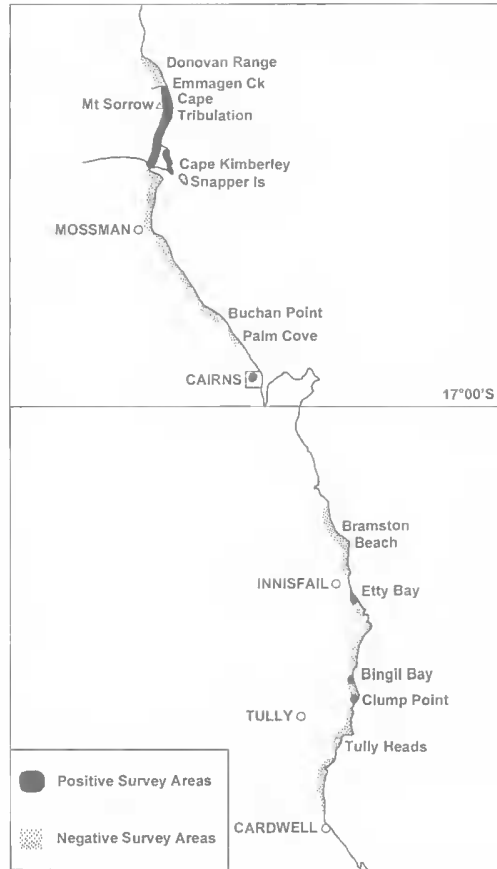


FIG. 1. Map of part of the Wet Tropics region of Queensland showing distribution of *Megacrania batesii* (Kirby). Presence of colonies is shown in black. Areas surveyed, but which proved negative, are shown stippled.

The length and width of eggs collected from Cape Tribulation, Etty Bay and Bingil Bay populations (sample size range 9-13) were measured using Vernier calipers. Width was regressed against length which was then used to compare differences among populations using a one-way ANOVA. In July, when newly emerged nymphs were abundant, we counted all *M. batesii* feeding on 40 *Pandanus* plants and calculated the average number of individuals supported by a single plant.

RESULTS AND DISCUSSION

DISTRIBUTION AND HABITAT. *Megacrania batesii* was found at five locations from Cape Tribulation to Clump Point (Fig. 1, Table 1). The

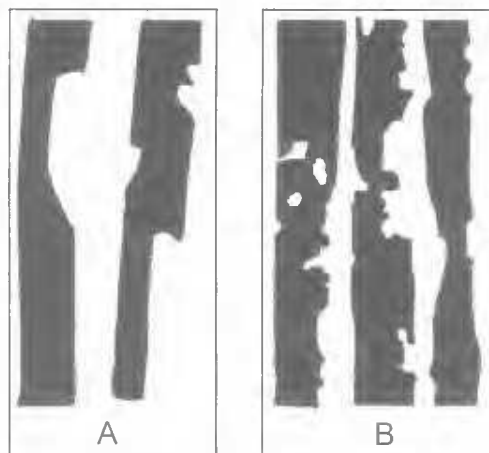


FIG. 2. Feeding marks on leaves of *Pandanus*: A, caused by *Megacrania batesii*; B, caused by the katydid, *Austrosalomona* sp.

Cape Tribulation population is confined to an area between the Daintree River in the south and Emmagen Creek in the north. *M. batesii* occur in *Pandanus* beside all types of shore line in this area. No *M. batesii* were found on Snapper Island or in suitable habitat with the host plant along the coastline between the Daintree River and Cairns.

Four separate populations of *M. batesii* were found south of the Daintree River. The Etty Bay population was located at the southern end of the beach and on the eastern aspect of the adjacent coastal range. Extensive searches north, south and inland of this area failed to locate any *Megacrania*. The Bingil Bay population, 30km to the south of Etty Bay, occurs over an area of 3ha extending 1.5km along the beach and 20m inland to the eastern edge of the Clump Mountain National Park and North Bingil Bay. A further 2.3km south of Bingil Bay, the Clump Point population occurs over an even smaller area of about 100m². A small population of *M. batesii* was also located in the Cairns Central Swamp in the suburb of Manunda within the City of Cairns. However this probably results from releases of captives by insects enthusiasts in Cairns (M. Trenerry, pers. comm. Jan. 1999).

South of Cairns, *M. batesii* appears to be restricted to areas where rainforests are adjacent to beaches. At Cape Tribulation, however, it was recorded beside rainforest streams or swamps up to 5km inland and at up to 300m altitude on Mt Sorrow. The phasmids frequently inhabit *Pandanus* growing on the seaward edge of beach vegetation. These plants are regularly subjected

to sea water spray, particularly during windy conditions at high tide, suggesting a high tolerance of salt.

The natural populations of *Megacrania* lie in high rainfall foci where annual rainfall exceeds 3000mm and driest quarter exceeds 160mm (Rainforest CRC, 1998). The presumably introduced colony in Cairns lies outside these rainfall levels.

FOOD PLANTS. During the survey, we observed *M. batesii* feeding on three species of *Pandanus* in the wild, *P. tectorius* Parkinson, *P. monticola* F.v.Muell. and *P. soloms-laubachii* F.v.Muell. In captivity, *M. batesii* fed on two other native species (*P. whitei* Martelli, and *P. genumifer* John) neither of which occur in the natural range of the phasmid. It also accepted the related climbing genus, *Freycinetia*, and the exotic species, *Pandanus utilis*.

At Clump Point, *Megacrania* was recorded on *P. tectorius* (the only *Pandanus* species present), while at Bingil Bay and Etty Bay *Megacrania* fed on both *P. tectorius* and *P. monticola*. At Cape Tribulation, the phasmids utilised three species, *P. tectorius*, *P. monticola* and *P. soloms-laubachii*.

The feeding scars caused by *M. batesii* are readily distinguished from those of the few other insects that eat *Pandanus*. Typically, *M. batesii* bites into the leaf on a slight angle from the margin towards the mid rib and then proceeds longitudinally, back to the margin (Figs 2A, 3B). By comparison the feeding scars of orthopterans (*Austrosalomona*, Tettigoniidae) tend to be more circular (Fig. 2B). The chewing patterns were used to detect *M. batesii*, particularly on tall, inaccessible plants. The first and second instar nymphs were found on young growth of the food plant, while adults mainly feed on older leaves.

DENSITY. Census of 40 occupied *Pandanus* plants in the field at Etty Bay and Bingil Bay revealed that a single leaf cluster typically supported 1 to 5 nymphs of instars 1 to 3 (mean 2.3, SE 0.197). We recorded no more than 3 adults per leaf cluster but M. Trenerry (pers. comm. 1999) reported up to 10 adults and sub-adults on one leaf cluster at Etty Bay. Heavy feeding damage to a young plant is shown in Fig. 3D.

REPRODUCTION AND DEVELOPMENT. The Cape Tribulation population contains both males and females, while the southern populations appear to reproduce by parthenogenesis

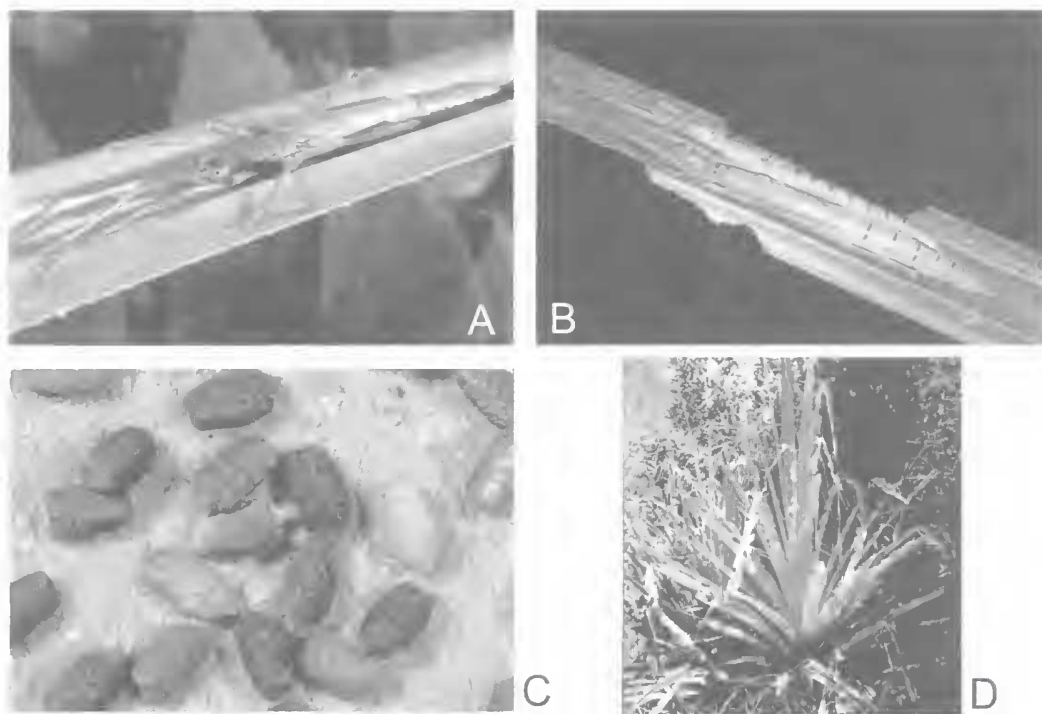


FIG. 3. *Megacrania batesii*. A, active adult ♀ on *Pandanus* leaf (Cape Tribulation); B, resting ♀ and last instar nymph on *Pandanus* leaf – note position of legs and feeding marks on leaf margins; note colour pattern of nymph (Etty Bay); C, eggs (Etty Bay); D, severe phasmid feeding damage to a juvenile *Pandanus* plant (Cooper Creek, Daintree).

given that no males were ever observed. Several males from Cape Tribulation readily mated with females from Etty Bay in the laboratory, but the resultant eggs did not hatch.

Megacrania batesii appears to have an annual life cycle. In the field at Cape Tribulation eggs were released from November to April and hatched from July to December. Adults then peaked from December to March. By July 1999 at the same locality there were abundant nymphs of all instars but an almost total absence of adults. However, during subsequent observations at Cape Tribulation in July 2000, *Megacrania* were abundant in all developmental stages including adults.

Eggs are shown in Fig. 3C. In captivity, parthenogenic females from Etty Bay produced between 60 to 70 eggs in their lifetime. Unlike many phasmids, *Megacrania* do not throw their eggs with a flick of the abdomen at the moment they are released. The relatively large eggs were dropped haphazardly to the ground or on to the

leaves of the host plant. The eggs often rolled down into the spiral centre of the *Pandanus* plant, where they were eventually covered and secured by frass from feeding adults. In time, a fungal growth cemented the frass into a solid mass in the axils. Examination of four medium sized *Pandanus* leaf clusters revealed a mean of 27.3 eggs trapped within the foliage of each plant.

There was a significant correlation between egg length and width ($R=0.495$, $p=0.003$), so only length data were used in further analysis. Eggs are very large, varying in length from 7.1–8.15mm (mode 7.79–7.91mm: 39.4%). There were no differences in egg length between populations (ANOVA, $F=1.2$, $df=2$, $p=0.32$), and the eggs appeared to have identical sculpturation and colour.

Mean body length of females at Etty Bay ($111.0\text{mm} \pm 0.95$, $n=7$) was not significantly different to that of females at Cape Tribulation ($106.9\text{mm} \pm 1.22$, $n=7$; $T=2.65$, $0.02 < p < 0.05$, $df=12$), but these were longer than males

TABLE 1. Geographical locations and classification of forest types (Tracey & Webb 1975) inhabited by *Megacrania batesii*.

Location	Forest type	Description	Coordinates
Cape Tribulation	1a	Complex Mesophyll Vine Forest	16°02'>16°14'30"S, 145°25'>145°28'25"E
Cape Tribulation	2a	Mesophyll Vine Forest	16°02'>16°14'30"S, 145°25'>145°28'25"E
Cape Tribulation	17	Coastal Beach Ridges and Swales	16°02'>16°14'30"S, 145°25'>145°28'25"E
Cape Tribulation	13a	Vine Forest	16°02'>16°14'30"S, 145°25'>145°28'25"E
Cape Tribulation	13d	Vine Forest	16°02'>16°14'30"S, 145°25'>145°28'25"E
Etty Bay	2a	Mesophyll Vine Forest	16°34'S, 146°05'30"E
Bingil Bay	2b	Mesophyll Vine Forest	17°49'45">17°50'15"S, 146°05'40">146°06'E
Clump Point	2b	Mesophyll Vine Forest	16°51'25"S, 146°07'E
Cairns C. Swamp		Fringing Mesophyll Vine Forest Swamp	16°55'S, 145°45'E

(75.3mm \pm 0.96, n = 10; T=1.96, 0.01<p<0.05, df=15).

BEHAVIOUR. Adults and nymphs of *M. batesii* rest within the deep groove on the upper surface of *Pandanus* leaves, or on the underside. They adopt a distinctive posture with front and mid legs stretched forward and hind legs directed backwards (Fig. 3B). While feeding, they assumed a position along the leaf margin and when disturbed, shuffled backwards to the centre of the plant using only their front and mid legs. Though both sexes are winged, *M. batesii* do not fly. The males, being more gracile and having longer wings, are capable of parachuting to the ground when disturbed. Females do not attempt to fly at all.

Most of the stages of *M. batesii* are well camouflaged on the green foliage. However, the last nymphal instar is quite conspicuous with most individuals being bright blue-green with dark segmental margins, yellow, red and black eyes, and red antennae and wing buds (Fig 3B).

PREDATORS. The following predators were observed feeding on *M. batesii*: huntsman spiders (Sparassidae), jumping spiders (Salticidae), centipedes (Scolopendrida), green tree ants (*Oecophylla smaragdina* Fabricius), praying mantids (*Hierodula majuscula* Tindale), katydids (Tettigoniidae) and Black Butcher Birds (*Cracticus quoyi* Lesson).

PARASITES. Some eggs from all three sub-populations were parasitised by a species of chalcidoid wasp, *Anastatus* sp (Eupelmidae: Eupelminae), identified by Dr Chris Burwell of the Queensland Museum. These gregarious endoparasitoids have brachypterous females and macropterous males. *Anastatus* are primary parasitoids of a wide variety of insects including

Blattaria, Hemiptera, Homoptera, Lepidoptera, Mantodea, Neuroptera, Orthoptera and Phasmida (Gibson, 1995). A total of 56 wasps emerged from 5 *M. batesii* eggs in July 1999 (range: 8-15, sex ratio: 1 male/6 females).

CONSERVATION. *Megacrania batesii* in north Queensland has so far been found to occur in five isolated populations in humid coastal habitats on the eastern aspect of the coastal escarpment between Mission Beach in the south and Emmagen Creek just north of Cape Tribulation. Even if *Megacrania* existed in those few inaccessible areas between Daintree River and Emmagen Creek that were too difficult to survey, they would still be located well within the Cape Tribulation population boundaries. Under IUCN criteria the species would meet the criteria for Vulnerable: D2 because their range is restricted to less than 100km² and could be endangered if any of the populations are extirpated.

The Cape Tribulation population, in particular, is under no threat because of the abundance of suitable habitat and because the core of the population is essentially protected within the Cape Tribulation National Park. The Etty Bay population appears to be relatively secure as it occurs within the Johnstone Shire's Conservation Area and is also situated within the Wet Tropics World Heritage Area. The Bingil Bay, Clump Point and Cairns Central Swamp populations are distributed over very small areas and therefore are of some conservation concern.

To fully evaluate the conservation status of the species, DNA assay of the existing populations would be very valuable. This would not only determine whether the four populations comprise a homogenous species or more than one taxonomic unit, but would also shed light on their geographic relationships. If genetic differences

between the five *M. batesii* populations is small, then we can assume that the species is more mobile than we suspect, and therefore presents little conservation concern. However, if the populations are genetically distinct, then they may represent declining remnants and conservation management should be applied. DNA analysis would also shed light on whether the Cairns Central Swamp population is introduced and, if so, from where.

ACKNOWLEDGEMENTS

We thank the Environmental Protection Agency, Queensland Parks and Wildlife Service for recognising the importance of invertebrate fauna in the Wet Tropics and for supporting this project. We also thank Mike Trenerry, Leasia Helderhof, Dr Andrew Dennis, Dr Jamie Seymour, Dr Stephen Garnett, Andrew Small and Lyle Naylor for their contributions and help, the Marine Parks personnel for their help to access Snapper Island, and Dr Chris Burwell for identifying the parasitic wasp.

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